CRATER LAKE NATIONAL PARK
GEOLOGIC RESOURCES MANAGEMENT ISSUES
SCOPING SUMMARY

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Executive Summary

A Geologic Resource Evaluation scoping meeting for Crater Lake National Park as held in Ashland, Oregon, on Wednesday afternoon, March 3, 2004. The scoping meeting participants identified the following as the most significant geologic resources management issues.

1. The potential for geothermal exploration and development adjacent to the park has long been an issue.

2. Water right rights and the drilling of a water well has become a recent issue.

3. Seismicity and geohazards monitoring and study is needed.

4. Paleoliminology – need to core the lake to study bottom sediments.

Introduction

The National Park Service held a Geologic Resources Evaluation scoping meeting for Crater Lake National Park (CRLA) in Ashland, Oregon, Wednesday afternoon, March 3, 2004. The purpose of the meeting was to discuss the status of geologic mapping in the park, the associated bibliography, and the geologic issues in the park. The products to be derived from the scoping meeting are: (1) Digitized geologic maps covering CRLA; (2) An updated and verified bibliography; (3) A scoping summary (this report); and (4) A Geologic Resources Evaluation Report which brings together all of these products.

Crater Lake National Park was established on May 22, 1902, by act of Congress (32 Stat. 202). Prior to this, the Crater Lake was administered by the General Land Office as part of the Cascade Range Forest Reserve. Total area of the park is about 183,224 acres.

The park has identified 56 quadrangles of interest. Of these, the park covers the following twelve: Welch Butte, Pumice Desert East, Pumice Desert West, Hamaker Butte, Thousand Springs, Red Blanket Mountain, Union Peak, Maklaks Crater, Sun Pass, Pothole Butte, Crater Lake East, and Crater Lake West. The remaining 44 maps extend coverage approximately two quads out in all directions.

Geologic maps include: U.S. Geological Survey Professional Paper 3 covering the park at a scale of 1:140,800 (Diller and Patton, 1902); MF-1507a, scale 1:62,500 (Smith, 1983) which takes in the extreme south end; and, Open-File Report 83-660, scale 1:167,000 (Sherrod and Benham, 1983) which covers the extreme northern part of the park. Three small scale geologic maps (scale 1:250,000) cover portions of the park and the surrounding quads of interest: Crescent (MacLeod and Sherrod, 1992), Klamath Falls, (Sherrod and Pickthorn, 1992), and Medford (Page, Blakeley, and Cannon, 1983). South of the park, Smith (1988) produced a geologic map at 1:62,500. A geologic map of the Fort Klamath quad is available from the State of Oregon.

Charlie Bacon with the U.S. Geological Survey (USGS) started mapping Crater Lake in 1979. The current geologic map is at a scale of 1:24,000. It is wider (east-west) than the park boundary but not as high (north-south) so some of the park is cut off. Strips on the northern end and southern end of the park have not been mapped. The map includes both bedrock and surficial geology and will be published as a Miscellaneous Investigations Map ("I" map) by the end of 2004 or early 2005. The mapping is also based on approximately 2,000 samples and about 100 radiometric age dates. Other products include 11 panoramic drawings of the caldera wall as well as a "fantasy map" of the bedrock. The work is in ArcInfo and can be made available to the park. A USGS bibliography of the mapping will also be made available to the park. A geochronology of Mt. Mazama will be published in a Geological Society of America Bulletin after the map is released.

Bacon's mapping work could be expanded to cover the north and south portions to the same scale and detail. This could be available by 2008. A goal is to obtain geologic coverage at least one quadrangle beyond the boundary. Currently, USGS map MF-1528 is available as a surficial reconnaissance map. Other work is in progress by the Oregon Department of Geology and Mining include possibly a digital version of the USGS map I-1891 (1991, scale 1:125,000) of the northern part of the park by D.R. Sherrod. Other quads in progress at 1:24,000 are Fuego, Wocus Bay, Soloman Butte, Applegate Butte, Agency Lake, Chiloquin, and S'Ocholis Canyon. Helpful information for Crater Lake geospatial data includes:
http://vulcan.wr.usgs.gov/Volcanoes/CraterLake/#
http://craterlake.wr.usgs.gov#
http://geopubs.wr.usgs.gov/i-map/i2790/#
http://vulcan.wr.usgs.gov/Volcanoes/CraterLake/Maps/map_mazama_general_geologic.html#

An NCRS soil survey has been completed. The survey was done in 1999-2001. The survey is available on line at www.or.nrcs.usda.gov. The survey includes ecological site descriptions. Other derivative products include geospatial data and an accompanying manuscript and an Access database. An ArcView extension has a soil data viewer which will help resource managers with soil interpretation.

Physiography

Crater Lake National Park is located in the Cascade Physiographic province. The Cascade Range is composed almost entirely of volcanic cones, vents and lava flows. It extends north into southern British Columbia - Mt. Garibaldi is the northernmost volcano - and south to Lassen Peak in California, the southernmost volcano. In Oregon the crest of the range averages about 5,000 feet, although the highest peaks are Mt. Hood at 11,360 feet, Mt. Jefferson at 10, 495 feet and South Sister at 10,354 feet (Baldwin, 1976). The highest volcanoes in the Cascade Range are Mount Rainier in Washington at 14,411 feet and Mount Shasta just north of Lassen at 14,161 feet. The USGS has identified 13 potentially active volcanoes in the Cascade Range of the U.S. Pacific Northwest, 11 of which have erupted in the last 4,000 years and 7 in the past 200 years (Dzurisin, *et. al.*,1999).

The Cascades are divided into the Western Cascades and the High Cascades. The Western Cascades are composed of older Tertiary (Late Eocene to Late Miocene) flows, tuffs, and intrusives. The High Cascades include the high peaks such as Mt. Hood, Mt. Jefferson, and South Sister that have erupted more recently. Deposits are almost entirely late Miocene to Holocene age (Baldwin, 1976). The eastern slope is steeper and more abrupt than the more gently sloping Western Cascades.

At a maximum depth of 1,932 feet, Crater Lake is the deepest lake in the United States, the second deepest in the Western Hemisphere, and the seventh deepest in the world. Average depth is about 1,500 feet. The surface elevation is 6,176 feet and the highest point on the rim (Hillman Peak) is 8,056 feet. Wizard Island is a small cone rising 764 feet above the surface of the water and has an elevation of 6,940 feet. The highest point in the park is 8,926 feet at Mount Scott, a parasitic cone from Mount Mazama, the volcano that formed Crater Lake.

Geologic History

The Cascades formed as a result of the collision of the San Juan de Fuca plate with the North American plate, a collision still in progress. The oceanic crust is being thrust under or subducted beneath the North American crust. This subduction began in the Early to Middle Tertiary as evidenced by the lava flows and pyroclastics of the Western Cascades. Some of these volcanics have been given formational names such as the Eocene Colestin Formation and the Little Butte Volcanics of Oligocene and early Miocene age (Baldwin, 1976). The Colestin Formation consists mainly of andesitic tuff, conglomerate, and tuffaceous sediments in the southern Oregon Cascades. The Little Butte Volcanics consist of a variety of flows and tuffs from 3,000 feet to 15,000 feet thick. Along the western margin of the Cascades in the northern part of Oregon, the middle Miocene flood basalts of the Columbia River overlie the Little Butte volcanics. Other volcanic formations of Middle to Upper Miocene include the Sardine Formation, Rhododendron Formation and the Boring Agglomerate (Baldwin, 1976). None of these formations are exposed in CRLA, but probably form the foundation upon which the volcanoes of the high Cascades are built.

By Late Miocene, as subduction continued, volcanic activity shifted slightly eastward forming the High Cascades. In the Pliocene, eruption of basalt and andesite flows built up lava plateaus upon which Mount Mazama began to form. A small island in Crater Lake known as the “Phantom Ship” is believed to be the remains of a small cone that formed in the Pleistocene as a precursor to Mazama. Mount Mazama is a composite volcano or stratovolcano; that is, it was built by alternating eruptions of lava flows (mostly andesitic) and pyroclastics, along with abundant intrusive dikes and sills. Mazama had a large number parasitic cones and flank eruptions represented today by Mount Scott (Harris and Tuttle, 1983).

During the Pleistocene, glaciation developed as Mazama began to grow. Much of Mazama was probably ice-covered during its eruptive history. The caldera walls of Crater Lake display glacial deposits interbedded with lava flows. The evidence indicates that there were several episodes of glacial advance and retreat, the latter likely due to eruptions of Mazama. Soil horizons with charred vegetation at the top of till deposits and overlain by lava flows indicate that there were quiescent periods between eruptions during which vegetation flourished.

Geomagnetic data indicate that most of the lavas of the High Cascades were of normal polarity. Since the last reversal (to normal polarity) took place about 700,000 years ago, most of the eruptive activity has taken place since that time (Cranson, 1982). At its maximum height, Mazama may have been over 12,000 feet and similar in size to Mt. Hood (Baldwin, 1976). Eruptions began to be more siliceous forming dacite domes, siliceous flows, and dacitic pyroclastics. These eruptions tended to be from vents north of the central vent: the vent of the Watchman andesite, the Hillman Peak cone, the vents of the Llao Rock, Cleetwood, and Redcloud dacite flows (Harris and Tuttle, 1983).

About 6,600 year ago Mount Mazama erupted a huge amount of ash that spread over the entire Pacific Northwest, from southern British Columbia and Alberta to northern California and Nevada, and east covering most of Idaho and the western one-third of Montana. It is estimated that 15 to 17 cubic miles of material was blown off the mountain. Mazama collapsed into a caldera 5 miles wide and 4,000 feet deep (Harris and Tuttle, 1983). It has been estimated that the amount of material blown out of the volcano plus the amount of lava that flowed out far exceeds the material of the cone that was lost. The difference must have come from the magma chamber which evacuated resulting in the collapse.

After this defining eruption, there was further activity that resulted in the formation of Wizard Island and two smaller cones on the caldera floor. Wizard Island rise about 2,600 feet above the caldera floor but is only 774 feet above water level. The larger of the two smaller cones, Merriam cone, lies near the southern edge of the caldera and, though submerged, rises about 1320 feet from the caldera floor (Harris, 1980). The accumulation of rain and snow resulted in the lake we see today.

Significant Geologic Resource Management Issues at Crater Lake National Park

1. Geothermal Exploration and Development

There have been in the past, and likely will be in the future, significant issues regarding the influx of geothermal waters into the lake as well as the potential for geothermal exploration and development outside the park. In 1986, California Energy Company Inc. put down two geothermal test wells outside the park boundary, hitting steam at about 1,300 feet. The company had about 97,000 acres of the adjacent Winema National Forest under lease and had planned to drill 24 sites, some within one-quarter mile of the boundary. Although there was concern from the public that drilling may drain the lake (highly unlikely), the major concern of the park was the potential development of geothermal facilities in close proximity to the park. These issues were of such concern that Congress singled out Crater Lake along with 21 other NPS units as needing special protection under Section 115 of the Department of the Interior and Related Agencies Appropriations Act for 1987 regarding geothermal leasing. This resulted in major monitoring and research efforts in the late '80s and early '90s. After the legislation was passed that required NPS input into future leasing and drilling proposals, interest in the area by Cal Energy and others declined. With the policy of the present administration emphasizing energy development, including geothermal resources, there still a potential for geothermal development to impact the park. The Crater Lake research did indicate that there is some influx of water at slightly elevated temperatures at the bottom of the lake. The concern now is that drilling may change this geothermal flow regime.

2. Water right rights and the drilling of a water well.

The park has proposed drilling a water well in the park. Although a water well would not tap geothermal waters, nonetheless, since the park has opposed geothermal drilling, the local public believes that this drilling should not be allowed either. There are also issues of water rights as well. The park does have surface water rights, but groundwater rights are questionable.

3. Seismicity and Geohazards

At present there is a low occurrence of earthquakes, but Charlie Bacon believes that the area may be due for a magnitude 7.5+ quake. There is no seismograph in the park and coverage in the area is poor. It may be possible to obtain an instrument from the USGS Volcano Hazard Team. However, rockfalls are an issue since a visitor was killed by a rockfall on the Cleetwood Cove Trail about 10 years ago. Help is needed to try to stabilize this trail, the only tail down the caldera wall to the lake. Major landslides into the lake could capsize tour boats, which are required to avoid the most hazardous areas.

4. Paleolimnology

The CRLA staff expressed a strong desire to study the sediments in the bottom of the lake. About two dozen 6-foot cores have been recovered. The park would like to continue this project to study the history of sedimentation, diatoms and other microfossils, and climatic history. Funding is needed to continue this project.

5. Other Issues

Caves: There are over 40 caves in the park that have not been inventoried and mapped. One cave was closed by the development of a road. There is a need for research on bats and other fauna. The park should work with the National Speleological Society (NSS) to develop a program of systematic inventory and research of the caves.

Disturbed Lands: Several old quarry sites need to be inventoried, evaluated (esp. for exotic plants), and reclaimed. Hazardous materials have been found in some including buried railroad cars with asbestos and PCBs. Some of these are 40-50 years old. The “Summer Dump” and “South Yard” are two sites that need to be reclaimed. The State of Oregon as well as the Geologic Resources Division should be contacted.

Wetlands: Wetlands have been identified but need more detailed study.

Unique Geologic Feature and Interpretation: The caldera left from the explosion and collapse of Mt. Mazama is one of the most unique features in the world. Although the last eruption was over 6,000 years ago, the Cascades are still highly active and the potential for further volcanic activity remains. There is ample opportunity for interpretation of the past, present and possible future of Mt. Mazama.

Scoping Meeting Participants

Tim Connors	Geologist	NPS, Geologic Resources Division
Sid Covington	Geologist	NPS, Geologic Resources Division
Anne Poole	Geologist	NPS, Geologic Resources Division
Ron Kerbo	Cave Specialist	NPS, Geologic Resources Division
Pete Biggam	Soil Scientist	NPS, Natural Resources Information Div.
Chris Currens	Aquatic Biologist	USGS, Biological Resources Division

Marsha Davis	Geologist	NPS, Columbia Cascades Support Office
Charlie Bacon	Research Geologist	USGS Volcano Hazards Team
Mac Brock	Chief, Resource Management	Crater Lake National Park
Mark Buktenica	Aquatic Ecologist	Crater Lake National Park
Tom Wiley	Geologist	Oregon Department of Geology
Daniel Sarr	Network Coordinator	NPS, Klamath Network
Bob Truitt	Data Manager	NPS, Klamath Network
Hanna Waterstat	Data Miner	NPS, Klamath Network

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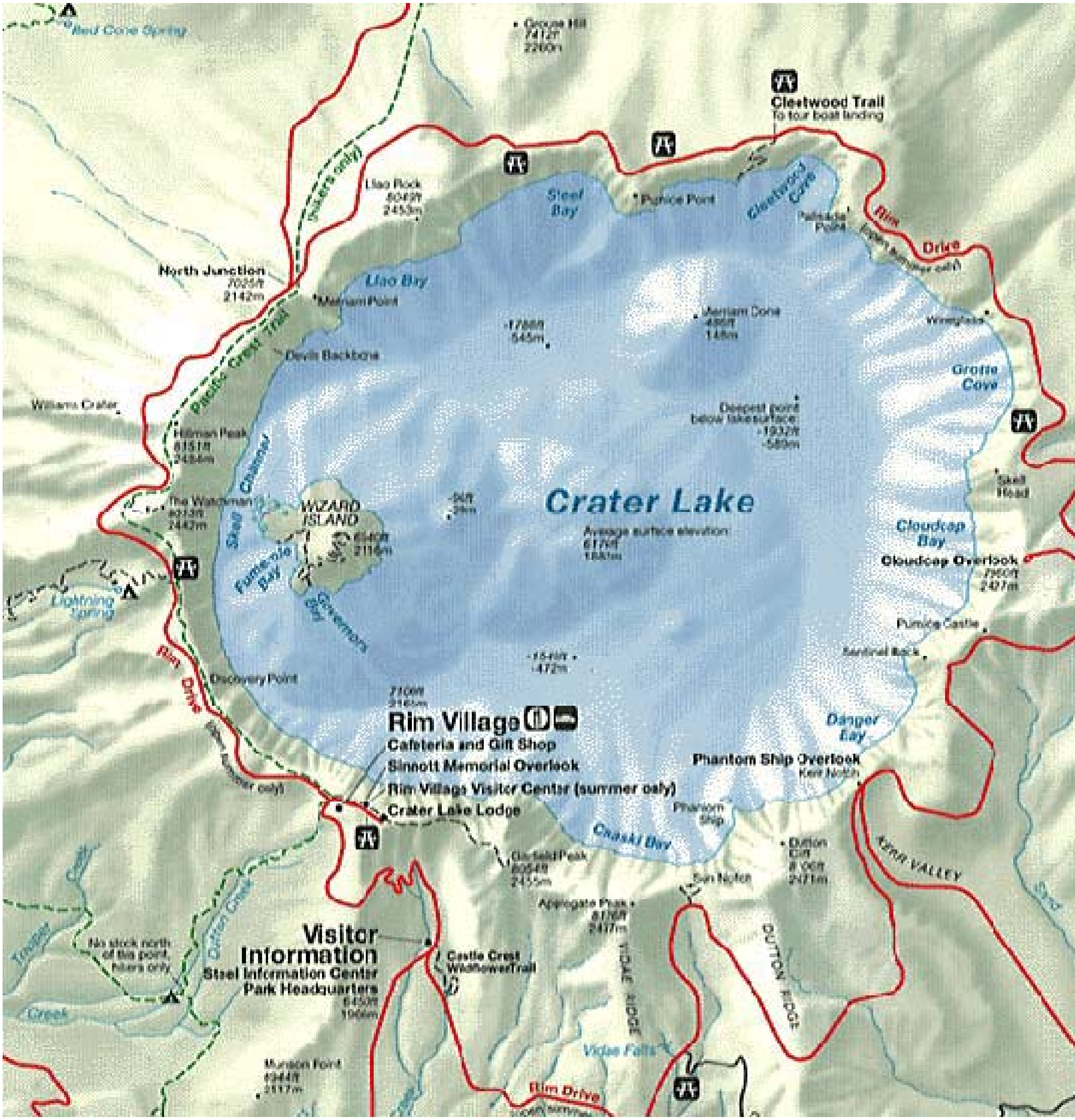

Red Cone Spring
Grouse Hill
7412ft
2260m
Cleetwood Trail
To tour boat landing
Llao Rock
8049ft
2453m
Steel Bay
Pumice Point
Cleetwood Cove
Palisade Point
Rim Drive
North Junction
7025ft
2142m
Llao Bay
Merriam Point
Merriam Cone
486ft
148m
-1788ft
545m
Devils Backbone
Pacific Crest Trail
Wineglass
Grotto Cove
Williams Crater
Deepest point below lakesurface
-1932ft
-589m
Hillman Peak
8151ft
2484m
Skell Channel
Skell Head
The Watchman
8013ft
2442m
WIZARD ISLAND
6940ft
2116m
Crater Lake
Average surface elevation
6178ft
1883m
Cloudcap Bay
Cloudcap Overlook
7960ft
2427m
Fumarole Bay
Governors Bay
Lightning Spring
Pumice Castle
Sentinel Rock
Rim Drive
Discovery Point
7100ft
2164m
Rim Village
Cafeteria and Gift Shop
Sinnott Memorial Overlook
Rim Village Visitor Center (summer only)
Crater Lake Lodge
Danger Bay
Phantom Ship Overlook
Kerr Notch
Phantom Ship
Chaski Bay
Dutton Cliff
8100ft
2471m
KERR VALLEY
Garfield Peak
8054ft
2455m
Sun Notch
Applegate Peak
8126ft
2477m
DUTTON RIDGE
VIDAE RIDGE
Visitor Information
Steel Information Center
Park Headquarters
6450ft
1966m
Castle Crest Wildflower Trail
No stock north of this point, hikers only
Dutton Creek
Trapper Creek
Vidae Falls
Munson Point
6944ft
2117m
Rim Drive